



Effect of climate change, connectivity, and socioeconomic factors on the expansion of the dengue virus transmission zone in 21st century Brazil: an ecological modelling study

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Abstract

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Background Globally, incidence of dengue fever has increased more than 30-times in the past 50 years, with outbreaks becoming frequent in tropical and subtropical countries. This rapid emergence has been attributed to increased urbanisation, globalisation, international mobility, and climate change. Brazil is endemic to all four dengue virus serotypes with outbreaks occurring in every region of the country. Previous studies identified geographical barriers to dengue diffusion, with some regions of Brazil being relatively protected from outbreaks. These regions included areas in the south of the country where seasonal temperatures were too cold for vectors to efficiently transmit the virus, regions of the western Amazon that were isolated from infectious hosts and vectors, and mountainous regions of southeast Brazil.

Methods In this ecological modelling study, we used a Bayesian spatiotemporal model to understand the effect of climate variation, connectivity between cities, and socioeconomic factors, such as urbanisation, on the expansion of the permanent dengue virus transmission zone in Brazil. We obtained monthly dengue fever case data from 5560 municipalities in Brazil for 2001–19 from the Notifiable Diseases Information System (SINAN) surveillance system. The model was fitted to an outbreak indicator defined as exceeding 300 cases per 100 000 inhabitants per year. Fixed effects included climate suitability and hydrometeorological variables obtained from the Climate Research Unit (University of East Anglia, Norwich, UK), the level of influence of a city from the Brazilian Regiões de Influência das Cidades study, and socioeconomic factors, such as urbanisation, from census data. Spatiotemporal random effects were included to account for unobserved heterogeneity, spatial autocorrelation, and temporal trends.

Findings Data from the past 10 years showed that pre-identified geographical barriers to dengue virus transmission are being eroded or destroyed completely. The emergence of dengue fever outbreaks in south Brazil coincided with an increase in the number of months per year with temperatures suitable for transmission.

Interpretation Understanding the factors that lead to the erosion of barriers to dengue virus transmission will help identify regions at risk of future outbreaks, and improve public health preparedness to emerging and re-emerging diseases.

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Contributors

SAL and RL conceived the study idea. SAL designed the research, collated the data, verified the data, analysed the data, and wrote the abstract. RL also verified the data. TE assisted with model development. CB, RC, and MSC provided data and insight. All authors reviewed and approved the abstract before submission.

Declaration of interests

We declare no competing interests.